

AD-E 410 711

AD



**CHEMICAL
SYSTEMS
LABORATORY**

US Army Armament Research and Development Command
Aberdeen Proving Ground, Maryland 21010

(12)

ADA 130006

TECHNICAL REPORT ARCSL-TR-82063

**CORROSION STUDIES OF THE M11 PORTABLE DECONTAMINATION
APPARATUS (PDA) BODY BY AQUEOUS BLEACH**

by

Lawrence C. Neeper

**Munitions Development Branch
Munitions Division**

April 1983



STG
JUN 7 1983
A

FILE COPY

Approved for public release; distribution unlimited.

82 07 03

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Disposition

Destroy this report when no longer needed. Do not return it to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCSL-TR-82063	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) CORROSION STUDIES OF THE M11 PORTABLE DECONTAMINATION APPARATUS (PDA) BODY BY AQUEOUS BLEACH		5. TYPE OF REPORT & PERIOD COVERED Technical Report June - September 1981
7. AUTHOR(s) Lawrence C. Neeper		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Commander, Chemical Systems Laboratory ATTN: DRDAR-CLN-D Aberdeen Proving Ground, MD 21010		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Commander, Chemical Systems Laboratory ATTN: DRDAR-CLJ-R Aberdeen Proving Ground, MD 21010		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1L162706A553-J
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE April 1983
		13. NUMBER OF PAGES 23
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE NA
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) M11 1 1/2 quart Portable Decontamination Apparatus (PDA) Clorox® Compatibility Sodium Hypochlorite Corrosion Cold Rolled steel Inhibition		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) It is desirable to be able to use the Portable Decontamination Apparatus (PDA) with dilute aqueous bleach solutions in chemical defense training exercises. The steel body of the PDA, however, is not compatible with the bleach solutions. The test described in this report shows that the corrosion of the PDA is serious, but that a film of oil is sufficient to ameliorate the corrosion. While use of an oil coating or of rinse water containing a rust inhibitor would tend to extend as received PDA service life with dilute aqueous bleach solutions, body wall failure (continued on reverse)		

UNCLASSIFIED

20. ABSTRACT (continued)

would be the ultimate outcome. Further, use of these techniques would place additional responsibility and burden on the user.

PREFACE

The work described in this report was authorized under Project 1L162706A553-J Chemical Training and Trialing Agents and Equipment. This work was started in June 1981 and completed in September 1981. The experimental data are recorded in notebook CSL 810107.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial hardware or software. This report may not be cited for purposes of advertisement.

Reproduction of this document in whole or in part is prohibited except with permission of the Commander, Chemical Systems Laboratory, ATTN: DRDAR-CLJ-R Aberdeen Proving Ground, Maryland 21010. However, the Defense Documentation Center and the National Technical Information Service are authorized to reproduce the document for United States Government purposes.

Acknowledgments

The author acknowledges the technical assistance received from Frederick E. Thompson, Chemical Systems Division, Product Assurance Directorate, and Eugene Probst, Development Support Division. Special acknowledgment is also given to John Dickie III, Munitions Division, for guidance and supervision throughout the entire project.

A

BLANK

CONTENTS

	Page
1 BACKGROUND AND OBJECTIVES	7
1.1 Background	7
1.2 Objectives	7
2 MATERIALS TO BE USED	7
3 PROCEDURES	8
3.1 Sample Preparation	8
3.2 Test Methods.	8
4 RESULTS AND DISCUSSION	10
4.1 Weight Loss	10
4.2 Corrosion Depth	10
4.3 Tensile Strength	16
4.4 Corrosion Inhibition	16
5 CONCLUSIONS	16
6 RECOMMENDATIONS	18

LIST OF FIGURES

1 Average Weight Change Unwelded Samples	11
2 Average Weight Change Welded Samples	12
3 Condition of 30-Cycle Treatment Samples Before Scraping	13
4 Condition of 30-Cycle Treatment Samples After Scraping	14
5 Corrosion Penetration in Sample 6	15
6 Corrosion Penetration in Sample E	15

LIST OF TABLES

1 Weight Change Data	9
2 Corrosion Depth Data	16
3 Tensile Data	17
4 Inhibited Corrosion Data	18

BLANK

CORROSION STUDIES OF THE M11 PORTABLE DECONTAMINATION APPARATUS (PDA) BODY BY AQUEOUS BLEACH

1. BACKGROUND AND OBJECTIVES

1.1 Background.

Consideration is being given to using aqueous sodium hypochlorite (ASH) as a simulant decontamination solution in chemical defense training exercises. It is known that ASH will quench the fluorescence of Tinopal CBS[®] or of sodium fluorescein in Polyethylene Glycol 200 (PEG 200) solutions of these fluorescent tracers. PEG 200 tracer mixes are used to simulate liquid chemical agent contamination in training exercises.

For training purposes it is desirable to be able to use ASH with the standard M11 1½-Quart Portable Decontamination Apparatus (PDA). It is known that ASH corrodes the cold-rolled steel body of the PDA. Presumably, some amount of corrosion could be tolerated in training use with ASH; however, severe corrosion, or no practical way of ameliorating such corrosion, during service with ASH would render such use of the PDA impractical.

1.2 Objectives.

The objectives of the work described in this report were to:

- Assess the nature and extent of corrosion of the PDA body from exposure to ASH, as would occur with repeated training use.
- Make a cursory assessment of possible means of ameliorating corrosion of the PDA body in service with ASH.

2. MATERIALS

In performing the work described in this report, the following materials were used:

- M11 Portable Decontamination Apparatus (PDA), NSN 4230-720-1618.
- Clorox[®] I, common household bleach, 5% aqueous sodium hypochlorite
- Epoxy paint, MIL-P-52192B.
- SAE 30-weight oil.
- Inhibitor, corrosion, liquid cooling system, DSA-400-71-C-2993.
- Metallograph, aus JENA Neophot 2, USA 06-06-013796.
- Tensile machine, Southwark-Tate-Emery, USA 06-06-001979.
- Analytic balance, Ainsworth Right-a-Weigh, to ±0.1 mg, USA-06-07-008278.

3. PROCEDURES

3.1 Sample Preparation.

Unused PDA bodies were cut into pieces of such a size that they would easily fit into 40 ml volume test tubes. There were two types of body samples, namely:

- Samples 1 through 14: Approximately 33 mm long by 14 mm wide, cut perpendicular to the body axis and containing the body wall welded seam.
- Samples A through N: Approximately 76 mm long by 14 mm wide, cut parallel to the body axis and not including the body wall welded seam.

The inside surface of each sample (the wetted surface) was masked with tape and two coats of epoxy paint were applied to the edges and back of each sample. The paint was allowed to air dry after each coat, and, after the second coat had dried, the masking tape was removed. The samples were then desiccated and weighed, until a constant weight (± 1.0 mg) was obtained.

The following two compositions of ASH solution were used:

- Solution A: 2/1 (V/V) Water/Clorox[®]I
- Solution B: 8/1 (V/V) Water/Clorox[®]I.

3.2 Test Methods.

PDA samples were subjected to cyclic exposure to ASH solutions by the schedule given in table 1. The steps in the exposure cycle were selected to simulate the treatment the PDA might receive in training use with ASH, and the steps in each cycle were as follows:

(a) Each sample was submerged in a fresh aliquot of the assigned ASH solution in a test tube for one hour at room temperature.

(b) After one hour the ASH solution was poured out of the test tube, and the sample was soaked in air (in the test tube) for an additional hour at room temperature while wet with residual bleach.

(c) The sample was rinsed with tap water, excess water was poured out and the sample was soaked in air (in the test tube) at room temperature while wet with residual tap water until the start of the next cycle. After each odd-numbered cycle, the samples sat for 2 hours. After each even-numbered cycle, the samples sat overnight, except after the 10th and 20th cycles, wherein samples designated for additional exposure cycles sat over the weekends.

There were two sample replicates for each combination of factors. After 10 cycles, samples A, B, G, H, I, 2, 7, and 8 were dried in a desiccator. Photographs of the corroded samples were taken and the corrosion products were scraped off with a steel spatula. The scraped samples were then rephotographed, desiccated, and reweighed.

Table 1. Weight Change Data

Sample	Number of Cycles/ Solution Strength*	Initial Weight	Final Weight	Weight Loss	Exposed Sample Area	Weight Loss Per Unit Area
		g	g	g	cm ²	mg/cm ²
A	10/A	13.9453	13.6947	0.2506	9.0	27.8
B	10/B	13.6397	13.4414	0.1983	7.6	26.1
G	10/B	11.6325	11.4800	0.1525	6.8	22.4
H	10/B	11.7525	11.5814	0.1711	7.3	23.4
C	20/A	13.6928	13.2264	0.4664	8.8	53.2
D	20/A	14.2909	13.7958	0.4951	9.1	54.4
I	20/B	13.9440	13.5971	0.3469	8.9	39.0
J	20/B	12.3706	13.0380	0.3326	7.1	46.8
E	30/A	14.1438	13.4428	0.7010	8.6	81.5
F	30/A	13.6327	12.9555	0.6772	7.9	85.7
K	30/B	13.8423	13.2858	0.5565	7.5	74.2
L	30/B	14.0975	13.4205	0.6770	8.6	78.4
1	10/A	6.4568	6.3687	0.0881	3.7	23.8
2	10/A	6.6619	6.5666	0.0953	3.7	25.8
7	10/B	6.7762	6.6893	0.0869	4.0	21.7
8	10/B	6.7452	6.6678	0.0774	3.6	21.5
3	20/A	6.6187	6.4264	0.1923	3.4	56.6
4	20/A	6.4447	6.2544	0.1903	3.4	56.0
9	20/B	6.4290	6.2473	0.1817	3.6	50.4
10	20/B	6.4251	6.2632	0.1619	3.7	43.7
5	30/A	6.7986	6.4386	0.3600	4.0	90.0
6	30/A	6.5116	6.2035	0.3081	3.9	79.0
11	30/B	6.0145	5.8069	0.2076	3.5	59.3
12	30/B	6.0512	5.8189	0.2323	3.4	68.3
M	Control	13.9608	13.9784	0.0024	---	---
N	Control	14.2047	14.2043	0.0004	---	---
13	Control	5.9839	5.9821	0.0018	---	---
14	Control	5.9869	5.9862	0.0007	---	---

*A - 2:1 (V/V, water:bleach) solution.

B - 8:1 (V/V, water:bleach) solution.

The same procedure was followed after 20 and 30 cycles with samples C, D, I, J, 3, 4, 9, and 10, and with samples E, F, K, L, 5, 6, 11, and 12, respectively.

Corresponding control samples, designated M, N, 13, and 14 and not subjected to exposure cycles, were weighed after application of epoxy primer paint, stored over desiccant and reweighed at the same time as the reweighing of the 10, 20, and 30-cycle test samples.

X-ray photographs were taken of each sample. From these photographs the locations of the deepest corrosion pit in each sample were estimated and then marked on the corresponding sample. The sample from each type/cycle group having the deepest pit was sectioned at this pit and mounted in clear optical plastic. Pit depth was measured from a Polaroid photograph taken at X 25 magnification.

The remaining samples were subjected to tensile strength test. A pencil mark was made at 3/8 inch from each end of each sample. Samples containing welds were pressed in a vise before tensile test to eliminate curvature. The tensile machine jaws were secured to each sample to obtain a bite of 3/8 inch on each end, and load was applied at a draw rate of 0.02 inches per second until sample failure.

A set of six additional samples (A1 through A6) was painted and weighed as described previously. Four of these samples (A1 through A4) were used to assess corrosion-inhibiting methods, while the other two (A5 and A6) were used as exposed controls. All samples were subjected to 10 exposure cycles and each cycle consisted of one hour soak in a fresh aliquot of ASH, and overnight standing damp with residual water in air in test tubes after rinse with water and draining. After the third and seventh cycles the samples sat for 3 days rather than overnight before the next cycle. Samples A1 and A2 were coated with SAE 30-weight oil before exposure to ASH solution in each cycle. With samples A3 and A4 corrosion inhibitor was included in the rinse water. After 10 cycles, the corrosion products were scraped off and the samples were desiccated and weighed.

4. RESULTS AND DISCUSSION

4.1 Weight Loss.

Data pertaining to sample weight loss due to cyclic exposure to ASH solutions for the first set of samples are given in table 1 and figures 1 and 2. The condition of the 30-cycle treatment samples before and after scraping is shown in figures 3 and 4, respectively. Samples exhibited general corrosion with a linear weight loss trend as a function of the number of exposure cycles and with a rate of weight loss dependent on ASH solution strength. A maximum weight loss of approximately 5% was observed in samples exposed to 30 cycles with ASH solution A.

4.2 Corrosion Depth.

Data pertaining to sample corrosion depth are given in table 2 and the deepest penetration in samples 6 and E is shown in figures 5 and 6, respectively. In samples containing the welded seam the deepest penetration occurred in the heat-affected zone adjacent to the weld. A maximum penetration of approximately 40% of the body wall thickness was observed in samples after 30 exposure cycles.

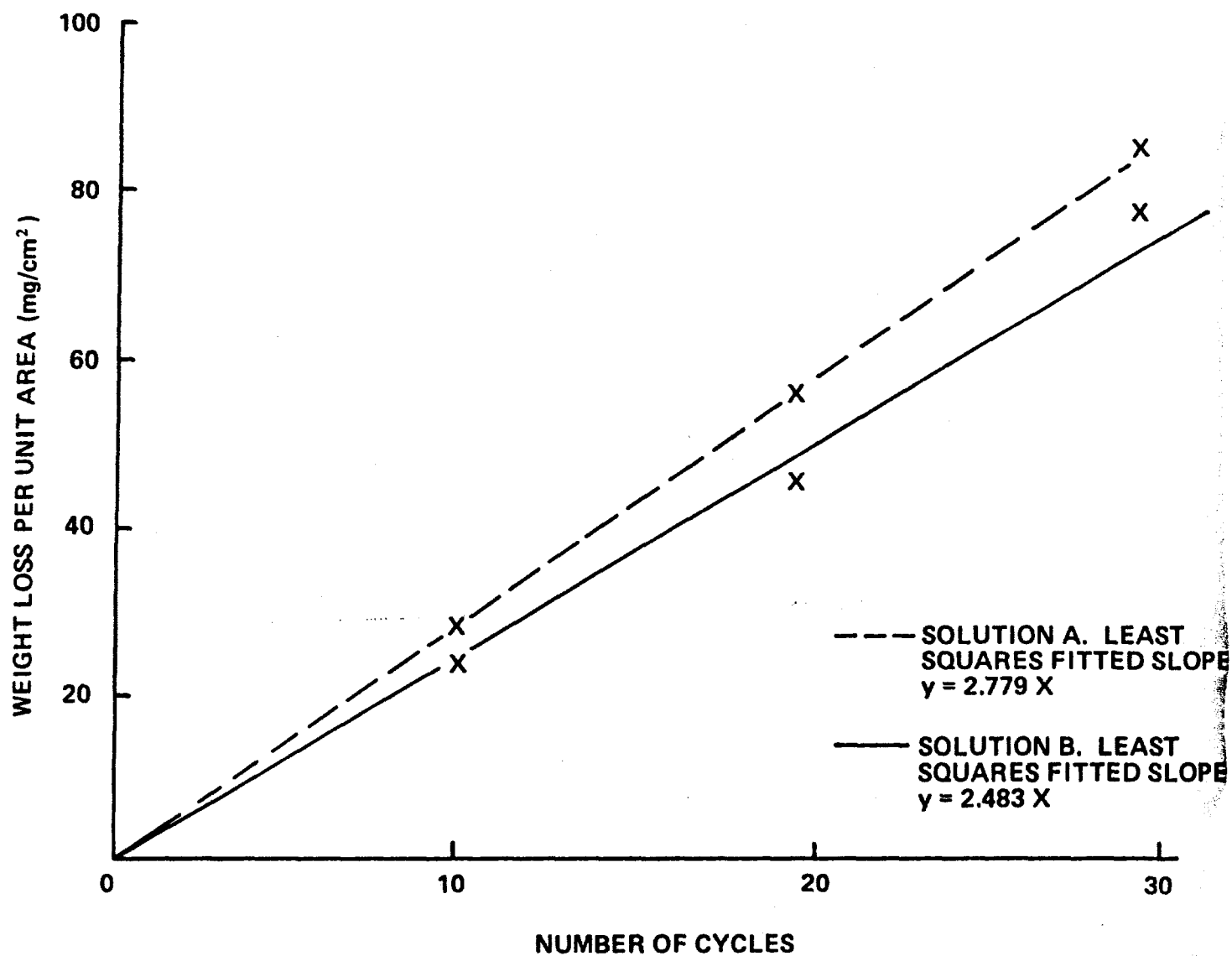


Figure 1. Average Weight Change Unwelded samples (Data points are the average value for those samples which have the same number of cycles and solution strength.)

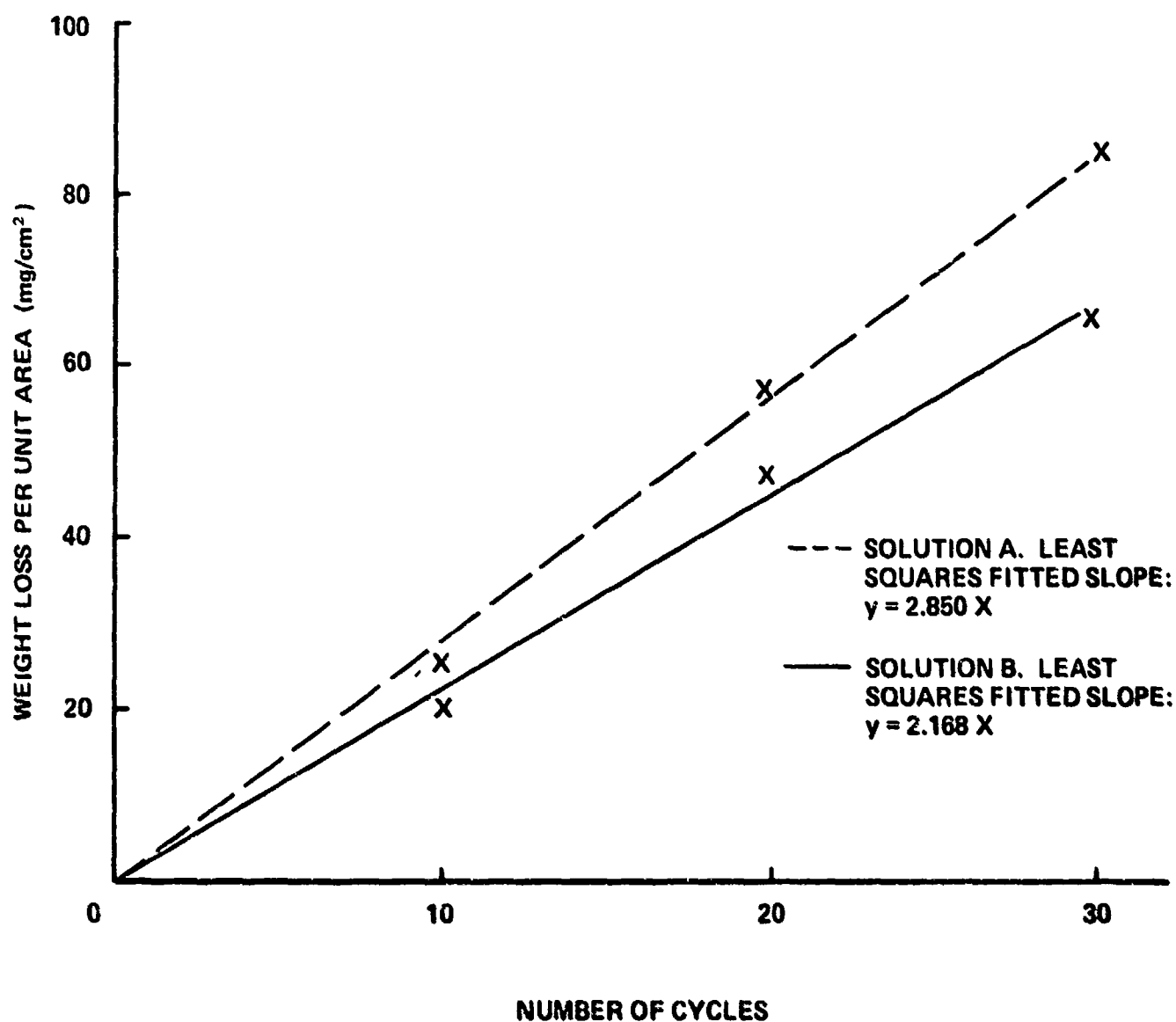


Figure 2. Average Weight Change Welded Samples (Data points are the average value for those samples which have the same number of cycles and solution strength.)

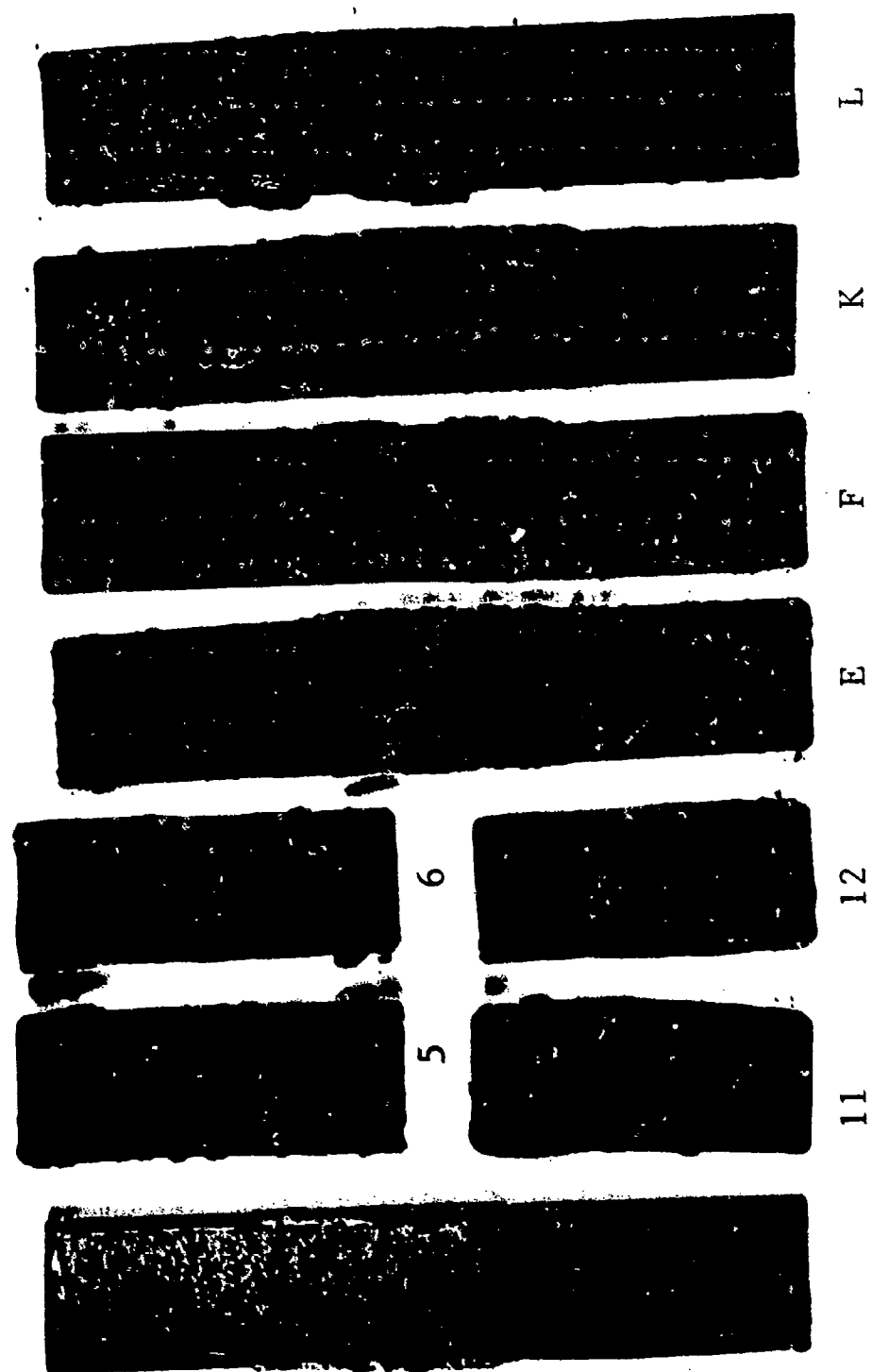


Figure 3. Condition of 30-Cycle Treatment Samples Before Scraping

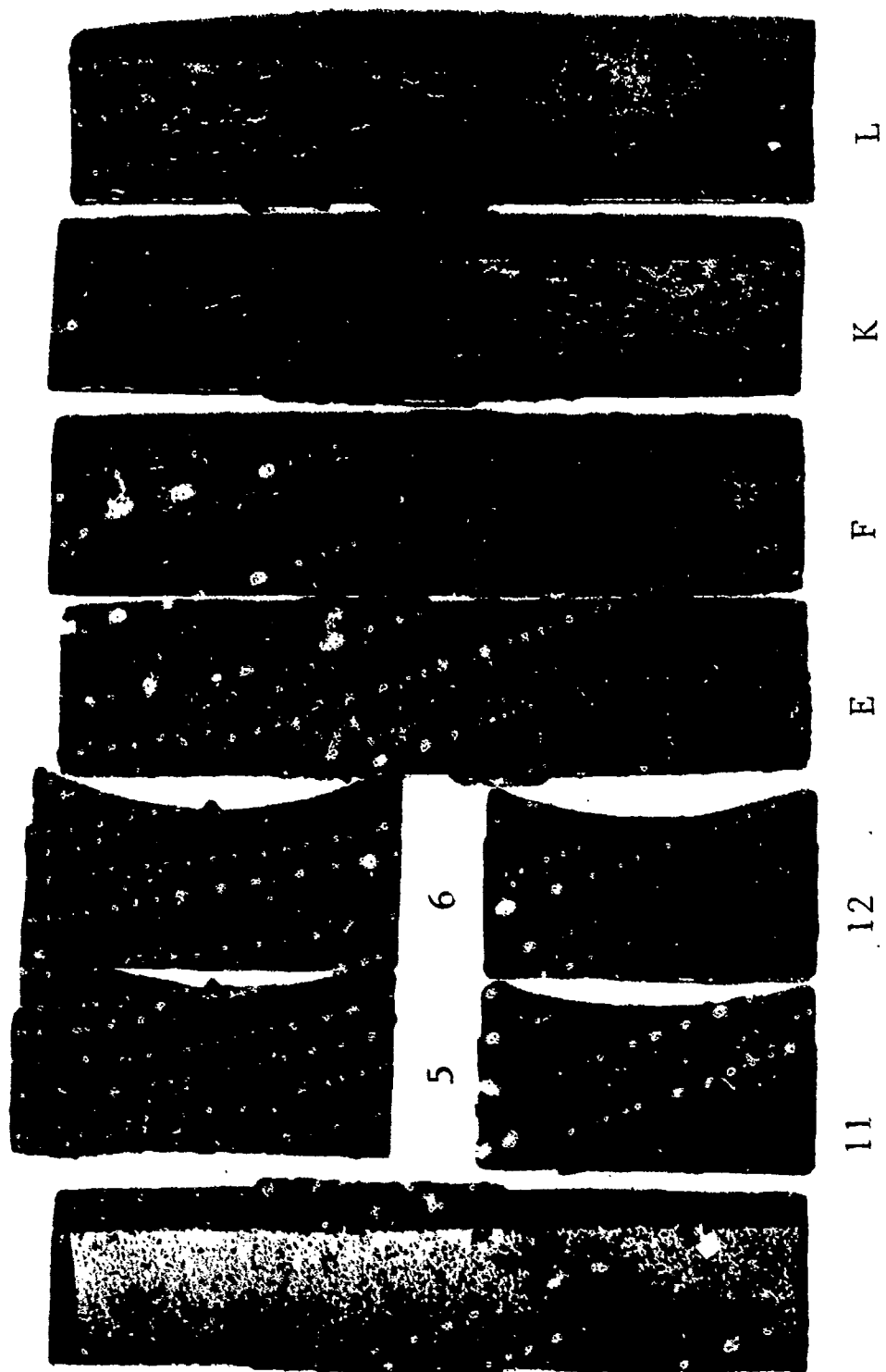


Figure 4. Condition of 30-Cycle Treatment Samples After Scraping

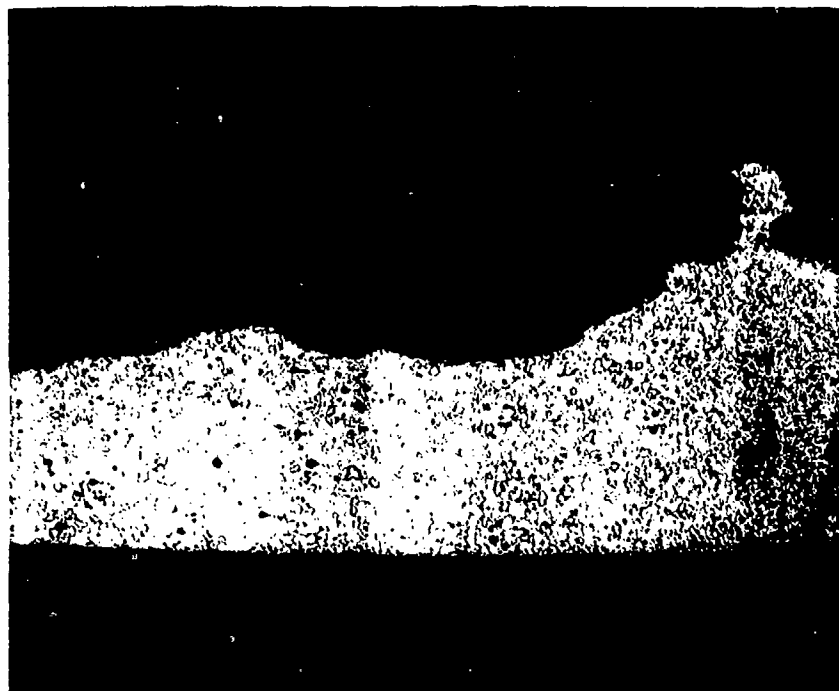


Figure 5. Corrosion Penetration in Sample 6

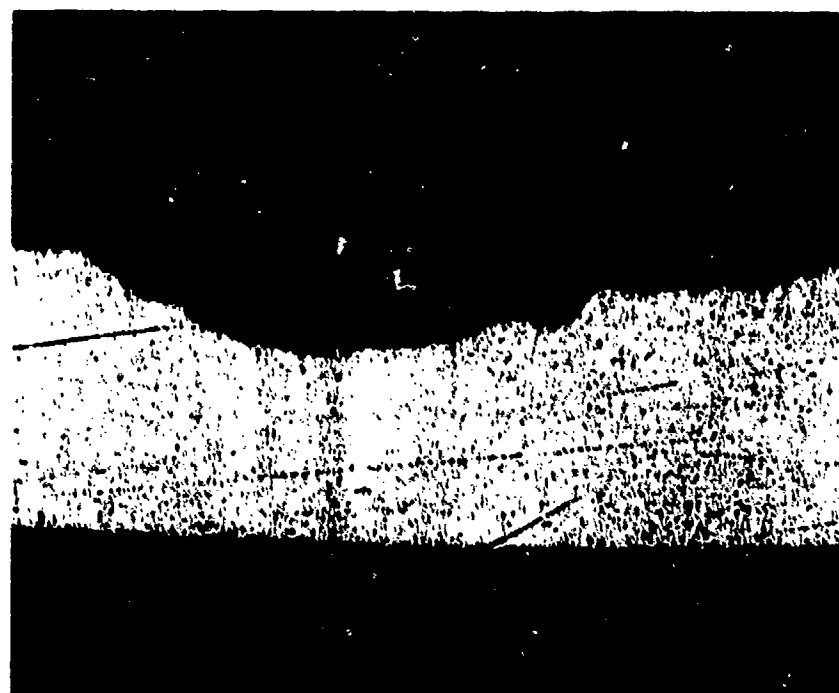


Figure 6. Corrosion Penetration in Sample E

Table 2. Corrosion Depth Data

Sample	Number of Cycles/ Solution Strength*	Thickness of Sample inches	Depth of Greatest Penetration inches	Percentage Depth Penetration
A	10/A	0.061	0.0063	10%
8	10/B	0.061	0.0066	10%
D	20/A	0.061	0.0189	31%
4	20/A	0.061	0.0128	21%
6	30/A	0.061	0.0256	42%
E	30/A	0.061	0.0226	37%

*A - 2:1 (V/V, water:bleach) solution.

B - 8:1 (V/V, water:bleach) solution.

4.3 Tensile Strength.

Data pertaining to sample tensile strength are given in table 3. It should be noted this test did not conform to any standard tensile strength test procedure, i.e., specimens did not conform to a standard pattern. Tensile strength for all samples was computed on the basis of as received body wall thickness. By inspection of the data, no significant reduction in the tensile strength of samples exposed to ASH appears to have occurred. Tensile strength at failure for all samples exceeded the computed maximum wall hoop stress, resulting from pressurizing a fully loaded PDA with two nitrogen cylinders, by a factor of 4 to 5.

4.4 Corrosion Inhibition.

Data pertaining to samples which were treated to inhibit corrosion are given in table 4. In terms of sample weight loss, pre-exposure treatment with oil or use of rust inhibitor in the rinse water inhibited corrosion by about 90% and about 50%, respectively. No penetration or tensile strength data were collected from these samples.

5. CONCLUSIONS

ASH solutions are incompatible with the as received (AR) PDA body. Although the severity of body corrosion based on overall weight loss or change in tensile strength seems to be minor or negligible from use with ASH, repeated use with ASH would eventually lead to body wall failure, probably through pitting and the appearance of small leaks. Catastrophic pressure failure, once the body wall has become sufficiently corroded and weakened, is a possibility.

While use of an oil coating or of rinse water containing a rust inhibitor would tend to extend AR PDA service life with ASH, body wall failure would still be the ultimate outcome. Further, use of these techniques would place additional responsibility and burden on the user.

Table 3. Tensile Data

Sample	Solution Strength*	Load to Failure lb	Sample Width inches	Tensile Strength** at Failure lb/in ²
B	10/A	1805	0.55	52,800
G	10/B	1500	0.47	51,200
H	10/B	1400	0.47	47,800
C	20/A	1770	0.55	51,800
I	20/B	1835	0.55	53,700
J	20/B	1530	0.51	48,200
F	30/A	1750	0.55	51,200
L	30/B	1790	0.58	50,600
1	10/A	1620	0.51	51,000
2	10/A	1640	0.51	51,700
7	10/B	1680	0.55	49,200
3	20/A	1630	0.53	49,400
9	20/B	1525	0.51	48,000
10	20/B	1570	0.51	49,400
5	30/A	1540	0.55	45,000
11	30/B	1665	0.51	52,400
12	30/B	1780	0.51	56,100
M	Control	1745	0.59	47,600
N	Control	1825	0.59	49,800
13	Control	1800	0.51	56,700
14	Control	1630	0.51	51,300

*A - 2:1 (V/V, water:bleach) solution.

B - 8:1 (V/V, water:bleach) solution.

**The walls of the PDA would see a hoop stress of approximately 6000 lb/in² after charging with a single nitrogen cylinder (to 190 psig) and 12,000 lb/in² after charging with two (to 360 psig).

Table 4. Inhibited Corrosion Data

Sample	Treatment*	Initial Weight	Final Weight	Weight Loss	Exposed Sample Area	Weight Loss Per Unit Area
		g	g	g	cm ²	mg/cm ²
A1	AA	13.8892	13.8593	0.0299	8.9	3.4
A2	AA	11.3082	11.2922	0.0160	7.8	2.1
A3	BB	13.4298	13.2821	0.1477	8.8	16.8
A4	BB	12.7400	12.6025	0.1375	7.9	17.4
A5	CC	13.7594	13.5266	0.2328	8.0	29.1
A6	CC	15.2411	14.9845	0.2566	9.0	28.5

*AA - Film of SAE 30-weight oil applied before each cycle.

BB - Rinsed with liquid cooling system corrosion inhibitor after each cycle.

CC - No applied rust inhibitor.

With or without service extension methods, some cleanup regimen would have to be followed after use of the AR PDA with ASH to prevent loosely bound corrosion products from obstructing or otherwise interfering with operation of the PDA discharge flow control components. While a malfunction in training use resulting from this aspect would only be a nuisance, malfunction in subsequent combat service use of the PDA with DS2 would be unacceptable.

A PDA modification which would enable dual service with either ASH or DS2, with negligible corrosion or added user burden in either service, is the best approach. From the technical point of view it is probable that something like an epoxy coating of the body wall would suffice for this purpose. The coating method should be simple and foolproof enough to enable in-the-field application. Since not all PDA are used in training, it is only necessary to modify PDA which are to be used with ASH. With modified PDA we must have assurance that subsequent combat service use will not be impaired by the modification. Combat service malfunction risk could of course be avoided completely if it were possible to dedicate a sufficient number of PDA to training use only.

6. RECOMMENDATIONS

Do not use an AR PDA in training service with ASH, where subsequently it might become necessary to use the PDA in combat service with DS2.

Assess the feasibility of using a body wall coating, such as epoxy, to enable dual training or combat service with ASH or DS2, respectively.

DISTRIBUTION LIST 4

Names	Copies	Names	Copies
CHEMICAL SYSTEMS LABORATORY			
ATTN: DRDAR-CLB	1	Commander	
ATTN: DRDAR-CLB-C	1	USASED, USAINSCOM	
ATTN: DRDAR-CLB-PO	1	ATTN: IAFM-SED-III	1
ATTN: DRDAR-CLB-PS	1	Fort Meade, MD 20755	
ATTN: DRDAR-CLB-R	1	DEPARTMENT OF THE ARMY	
ATTN: DRDAR-CLB-R(A)	1	HQDA	
ATTN: DRDAR-CLB-R(M)	1	ATTN: DAMO-NCC	1
ATTN: DRDAR-CLB-R(S)	1	ATTN: DAMO-NC/COL Robinson	1
ATTN: DRDAR-CLB-T	1	WASH DC 20310	
ATTN: DRDAR-CLB-TE	1		
ATTN: DRDAR-CLC-B	1	Federal Emergency Management Agency	
ATTN: DRDAR-CLC-C	1	Office of Research/NPP	
ATTN: DRDAR-CLC-E	1	ATTN: David W. Bensen	1
ATTN: DRDAR-CLF	1	Washington, DC 20472	
ATTN: DRDAR-CLJ-R	1		
ATTN: DRDAR-CLJ-L	2	HQ DA	
ATTN: DRDAR-CLJ-M	1	Office of the Deputy Chief of Staff for	
ATTN: DRDAR-CLN	1	Research, Development & Acquisition	
ATTN: DRDAR-CLN-TE	1	ATTN: DAMA-CSS-C	1
ATTN: DRDAR-CLT	1	Washington, DC 20310	
ATTN: DRDAR-CLW-C	1		
ATTN: DRDAR-CLW-P	1	HQ Sixth US Army	
ATTN: DRDAR-CLW-E	1	ATTN: AFKC-OP-NBC	1
ATTN: DRDAR-CLY-A	1	Presidio of San Francisco, CA 94129	
ATTN: DRDAR-CLY-R	1		
COPIES FOR AUTHOR(S)			
Munitions Division (CLN-D)	10	Commander	
RECORD COPY: DRDAR-CLN-A	1	DARCOM, STITEUR	
		ATTN: DRXST-STI	1
		Box 48, APO New York 09710	
DEPARTMENT OF DEFENSE			
Defense Technical Information Center		Commander	
ATTN: DTIC-DDA-2	12	USASTCFEO	
Cameron Station, Building 5		ATTN: MAJ Mikeworth	1
Alexandria, VA 22314		APO San Francisco 96328	
Director		HQ, 5th Infantry Division (Mech)	
Defense Intelligence Agency		ATTN: Division Chemical Officer	1
ATTN: DB-4G1	1	Fort Polk, LA 71459	
Washington, DC 20301			

Commander
US Army Nuclear & Chemical Agency
ATTN: MONA-WE
7500 Backlick Rd, Bldg 2073
Springfield, VA 22150

Army Research Office
ATTN: DRXRO-CB (Dr. R. Ghirardelli)
P.O. Box 12211
Research Triangle Park, NC 27709

OFFICE OF THE SURGEON GENERAL

Commander
US Army Medical Bioengineering Research
and Development Laboratory
ATTN: SGRD-UBD-AL, Bldg 568
Fort Detrick, Frederick, MD 21701

Commander
USA Medical Research Institute of
Chemical Defense
ATTN: SGRD-UV-L
Aberdeen Proving Ground, MD 21010

US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND

Commander
US Army Materiel Development and
Readiness Command
ATTN: DRCLDC
ATTN: DRCSF-P
5001 Eisenhower Ave
Alexandria, VA 22333

PM Smoke/Obscurants
ATTN: DRCPH-SMK-S
Aberdeen Proving Ground, MD 21005

Commander
US Army Foreign Science & Technology Center
ATTN: DRXST-MT3
220 Seventh St., NE
Charlottesville, VA 22901

Director
US Army Materiel Systems Analysis Activity
ATTN: DRXSY-MP
ATTN: DRXSY-CA (Mr. Metz)
Aberdeen Proving Ground, MD 21005

Commander
US Army Missile Command
Redstone Scientific Information Center
ATTN: DRSMI-RPR (Documents)
Redstone Arsenal, AL 35809

Director
DARCOM Field Safety Activity
ATTN: DRXOS-C
Charlestown, IN 47111

Commander
US Army Natlck Research and Development
Laboratories
ATTN: DRDNA-O
ATTN: DRDNA-IC
ATTN: DRDNA-ICAA
ATTN: DRDNA-IM
ATTN: DRDNA-ITF (Dr. Roy W. Roth)
Natlck, MA 01760

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND

Commander
US Army Armament Research and
Development Command
ATTN: DRDAR-LCA-L
ATTN: DRDAR-LCU-CE
ATTN: DRDAR-NC (COL Lynn)
ATTN: DRDAR-SCM
ATTN: DRDAR-SCS
ATTN: DRDAR-TDC (Dr. D. Gyorg)
ATTN: DRDAR-TSS
ATTN: DRCPH-CAWS-AM
Dover, NJ 07801

US Army Armament Research and Development Command Resident Operations Office ATTN: DRDAR-TSE-OA (Robert Thresher) 1 National Space Technology Laboratories NSTL Station, MS 39529	Commandant US Army Missile & Munitions Center and School ATTN: ATSK-CM 1 ATTN: ATSK-TME 1 Redstone Arsenal, AL 35809
Commander ARRADCOM ATTN: DRDAR-QAC-E 1 Aberdeen Proving Ground, MD 21010	Commander US Army Logistics Center ATTN: ATCL-MG 1 Fort Lee, VA 23801
Commander USA Technical Detachment 1 US Naval EOD Technology Center Indian Head, MD 20640	Commandant US Army Chemical School ATTN: ATZN-CM-C 1 ATTN: ATZN-CM-AFL 2 ATTN: ATZN-CM-TPC 2 Fort McClellan, AL 36205
US ARMY ARMAMENT MATERIEL READINESS COMMAND	
Commander US Army Armament Materiel Readiness Command ATTN: DRSAR-ASN 1 ATTN: DRSAR-IRW 1 Rock Island, IL 61299	Commander USAAVNC ATTN: ATZQ-D-MS 1 Fort Rucker, AL 36362
Commander USA ARRCOM ATTN: SARTE 1 Aberdeen Proving Ground, MD 21010	Commander US Army Infantry Center ATTN: ATSH-CD-MS-C 1 Fort Benning, GA 31905
Commander US Army Dugway Proving Ground ATTN: Technical Library (Docu Sect) 1 Dugway, UT 84022	Commander US Army Infantry Center Directorate of Plans & Training ATTN: ATZB-DPT-PO-NBC 1 Fort Benning, GA 31905
US ARMY TRAINING & DOCTRINE COMMAND	
Commandant US Army Infantry School ATTN: CTDD, CSD, NBC Branch 1 Fort Benning, GA 31905	Commander USA Training and Doctrine Command ATTN: ATCD-N 1 Fort Monroe, VA 23651
	Commander US Army Armor Center ATTN: ATZK-CD-MS 1 ATTN: ATZK-PPT-PO-C 1 Fort Knox, KY 40121

Commander
USA Combined Arms Center and
Fort Leavenworth
ATTN: ATZL-CAM-IM
Fort Leavenworth, KS 66027

US ARMY TEST & EVALUATION COMMAND

Commander
US Army Test & Evaluation Command
ATTN: DRSTE-CM-F
ATTN: DRSTE-CT-T
Aberdeen Proving Ground, MD 21005

DEPARTMENT OF THE NAVY

Project Manager
Theatre Nuclear Warfare Project Office
ATTN: TN-09C
Navy Department
Washington, DC 20360

Chief of Naval Research
ATTN: Code 441
800 N. Quincy Street
Arlington, VA 22217

Commander
Naval Explosive Ordnance Disposal
Technology Center
ATTN: AC-3
Indian Head, MD 20640

Officer-in-Charge
Marine Corps Detachment
Naval Explosive Ordnance Disposal
Technology Center
Indian Head, MD 20640

Commander
Naval Surface Weapons Center
Code G51
Dahlgren, VA 22448

Chief, Bureau of Medicine & Surgery
Department of the Navy
ATTN: MED 3C33
Washington, DC 20372

Commander
Naval Air Development Center
ATTN: Code 2012 (Dr. Robert Helmbold)
Warminster, PA 18974

US MARINE CORPS

Commandant
HQ, US Marine Corps
ATTN: Code LMW-50
Washington, DC 20380

Commanding General
Marine Corps Development and
Education Command
ATTN: Fire Power Division, D091
Quantico, VA 22134

DEPARTMENT OF THE AIR FORCE

ASD/AESD
Wright-Patterson AFB, OH 45433

HQ AFSC/SDZ
ATTN: CPT D. Riediger
Andrews AFB, MD 20334

HQ, AFSC/SDNE
Andrews AFB, MD 20334

HQ, AFSC/SCB
Andrews AFB, DC 20334

HQ, NORAD
ATTN: J-3TU
Peterson AFB, CO 80914

AFAMRL/HE
ATTN: Dr. Clyde Replogle
Wright-Patterson AFB, OH 45433

HQ AFTEC/TEL
Kirtland AFB, NM 87117

USAF TAWC/THL
Eglin AFB, FL 32542

AFATL/DLV
Eglin AFB, FL 32542

USAF SC
ATTN: AD/YQ
ATTN: AD/YQO (MAJ Owens)
Eglin AFB, FL 32542

USAFSAM/VN
Deputy for Chemical Defense
ATTN: Dr. F. Wesley Baumgardner
Brooks AFB, TX 78235

AFAMRL/TS
ATTN: COL Johnson
Wright-Patterson AFB, OH 45433

AMD/RDTK
ATTN: LTC T. Kingery
Brooks AFB, TX 78235

AMD/RDSM
Brooks AFB, TX 78235

AMD/RDSX
Brooks AFB, TX 78235

AD/XRO
Eglin AFB, FL 32542

OUTSIDE AGENCIES

Battelle, Columbus Laboratories
ATTN: TACTEC
505 King Avenue
Columbus, OH 43201

Toxicology Information Center, JH 652
National Research Council
2101 Constitution Ave., NW
Washington, DC 20418

US Public Health Service
Center for Disease Control
ATTN: Lewis Webb, Jr.
Building 4, Room 232
Atlanta, GA 30333

1 Director
Central Intelligence Agency
ATTN: AMR/ORD/DD/S&T
Washington, DC 20505

1 ADDITIONAL ADDRESSEES

1 Commandant
Academy of Health Sciences, US Army
ATTN: HSHA-CDH
1 ATTN: HSHA-IPM
2 Fort Sam Houston, TX 78234

1 Commander
217th Chemical Detachment
ATTN: AFVL-CD
Fort Knox, KY 40121

1 Headquarters
US Army Medical Research and
Development Command
ATTN: SGRD-RMS
Fort Detrick, MD 21701

1 Stinson Library (Documents)
Academy of Health Sciences, US Army
Bldg. 2840
1 Fort Sam Houston, TX 78234